



MINISTRY OF HOUSING AND LOCAL
GOVERNMENT

Report of Local Inquiry into the
**Causes of Damage to Houses
at Hatfield New Town**



LONDON
HER MAJESTY'S STATIONERY OFFICE
1958
ONE SHILLING NET

2, Mitre Court Buildings,
Temple, E.C.4.
27th June, 1958.

SIR,

I have the honour to present my Report as to the causes of damage to roofs at Hatfield.

I am, Sir,
Your obedient Servant,
MICHAEL E. ROWE.

THE RT. HON. HENRY BROOKE,
Minister of Housing and Local Government,
Whitehall, S.W.1.

Report by Michael Edward Rowe, Esq., C.B.E., Q.C., appointed by the Minister of Housing and Local Government in exercise of his powers under Section 19 of the New Towns Act, 1946 and Section 51 of the Town and Country Planning Act 1944 for the purpose of holding a local inquiry into the causes of the damage to houses at Hatfield during a storm early on the 4th November, 1957.

REPORT

1. My terms of reference were to hold a local Inquiry into the causes of the damage to houses at Hatfield during a storm early on the 4th November, 1957. I held such an Inquiry at the Cavendish Hall, Roe Green Centre, Bishop's Rise, Hatfield, on March 18, 19, 20, 21, 24 and 26 and May 20, 21, 22 and 23, 1958. A list of those appearing is set out in Appendix A : a list of Exhibits is in Appendix B. A copy of the Shorthand Note has been supplied to the Ministry. I also inspected some of the damaged houses and the wreckage adjacent thereto and certain other houses which, though undamaged, had been stripped so as to permit an investigation of their roof structures.

2. The background facts as to which there was no real dispute were as follows :

- (1) By an agreement [Exh. DC 4] dated the 30th September, 1955, and made between the Hatfield Development Corporation (therein called the Employer) of the one part and George Wimpey and Co. Ltd. (therein called the Contractors) of the other part, the Contractor undertook to erect 383 "C" Type Houses and works in connection therewith at Hazelgrove in the South End Neighbourhood of Hatfield for the consideration therein mentioned. The houses were to be built in accordance with certain drawings and a specification [Exh. DC 5 and 6] prepared by Messrs. Lionel Brett and Kenneth Boyd who were appointed 'the Architect' for the purposes of the Agreement and upon and subject to the conditions set out in the Agreement, which followed substantially the standard R.I.B.A. form, adapted for the use of local authorities where quantities do not form part of the contract.

The first sentence of condition 1 was as follows : "The contractor shall carry out and complete the Works in accordance with this contract in every respect in accordance with the directions and to the reasonable satisfaction of the Architect". Condition 8 entitled the Employer to appoint "a Clerk of Works whose duty shall be to act solely as inspector on behalf of the Employer under the directions of the Architect". The Corporation duly appointed one George Henry Garnett as such Clerk of Works and he acted as such throughout the execution of the works. Possession of the site was given to the Contractors on the 3rd January, 1955. The works were finally completed in January 1957.

- (2) The site is in the southern part of the New Town being developed by the Corporation. It rises about 50 feet, sloping to the south-west and exposed to the south and south-west. The layout of the 383 houses

is shown on Exhibit DC 7. They were of two storeys and were built in terrace blocks of from two to sixteen houses. The blocks were curved to follow approximately the contours of the ground. The houses were of cheap construction costing about £1,400 each.

- (3) All the houses had mono-pitch roofs at an angle of 6 degrees with overhanging eaves front and back. They were of a type rarely, if ever, used before in this country having an outer covering of aluminium. A more detailed account of the structure of each roof is given in paragraph 4 hereof.

The walls of the houses were to be made of "No Fines" concrete (i.e. a concrete without sand) in the construction of which the Contractors were admittedly specialists. As designed, at the top of each front and back wall there was to be a dense concrete beam (i.e. ordinary concrete).

- (4) During the night of 3rd/4th November, 1957 (by which date all the houses were occupied) a deepening depression moved north-east across England. Its centre was to the north of Hatfield and was nearest to the New Town between 3 and 4 a.m. The meteorological experts (Mr. Veryard and Mr. Durst) were in substantial agreement that during that time the maximum "one minute wind" would have had a velocity of about 58 m.p.h. with "five second gusts" of up to about 70 m.p.h.

The British Standard Code of Practice C.P.3, Chapter V (1952) [Exh. DC 3] deals with the subject of loading in relation to the functional requirements of buildings and contains in summary form the knowledge then available. Table 3 on page 13 shows that these velocities represented conditions in excess of Exposure B and both experts agreed that in the light of the information they had collected the site ought to be regarded as subject to Exposure C. In 1954/5 however an architect seeking advice from the local authority would have been told Exposure B was applicable. But it became unnecessary to consider the meteorological evidence in detail because it became common ground that the wind on the night of 3rd/4th November, 1957, was not of such force as to be outside the range of factors properly to be taken into account in the design of these houses. The first question posed in paragraph 3 *infra* must therefore be answered "No".

- (5) This wind caused very serious damage to the roofs of a number of these houses [Exh. DC 7] though it did little or no damage to other roofs in Hatfield. Of these houses no less than 28 lost their roofs completely: 18 lost the whole or part of their roof covering, but kept the greater part of their roof timbers: and in 47 other houses the roof lifted (from very slightly to obviously), but remained intact. The first group presented not only the most striking but the most informative evidence as to what had occurred. From the statements of two eyewitnesses Messrs. Davies and Clements and from the inspection I was able to make of the wreckage of some (which had been very sensibly preserved as evidence) it is clear that the entire roof structure lifted clean off the walls in one piece and then overturned and fell in the garden where it lay virtually intact. Indeed one could see three consecutive roofs in that condition.

- (6) An examination of the plan of the damage [Exh. DC 7] illustrates the unpredictable vagaries of wind forces. It suggests (i) that the roads running in a southerly or south-westerly direction, e.g. Bradshaws, and Redhill Drive-Hazel Grove, acted as funnels for the wind and (ii) that when the wind had done its worst to the first frontal obstacle, it lifted over the next row of houses and fell again upon the row behind, e.g. Furzen Crescent and the two sides of Shallcross Crescent.

There was no evidence that the roofs which were undamaged were more securely held down to the walls than those which were damaged. The conclusion to be drawn from an inspection of the roof structures of some undamaged houses which were uncovered for the purpose, is that they were spared because of their situation in relation to the wind and because of the vagaries of the wind, and not because they were more securely fixed. It would however be going too far in my opinion to say that it is impossible that any were saved by a few more nails.

- (7) No one found fault with the Fural aluminium sheeting which formed the roof covering nor with the method of its attachment to the roof structure.

3. In his opening speech Mr. Scarmian, Q.C. for the Corporation, posed the questions which he considered were the vital ones in the Inquiry and, though Mr. Stewart Brown, Q.C., had some minor reservations as to their phraseology, they were adopted by the principal protagonists as correct.

They were :

- (1) Was the wind of such a force as to be outside the range of factors properly to be taken into account in the design of the houses in question ?
- (2) Did the design of the houses make any, and if so what, provision for securing the roofs ?
- (3) Was such provision sufficient on the basis of such factors as the Architect might reasonably have been expected to take into account ?
- (4) Were sufficient steps taken by the Architect to communicate to the Contractors his intentions for securing the roof to the buildings ?
- (5) Did the Contractors build the roofs in accordance with the Architect's design or instructions (including the contract documents and specification) and in a workmanlike manner ?
- (6) Did any failure in design or communication of design or in supervision or in construction contribute in any degree to the causation of the damage ?

4. As I have already said, the roofs of these houses were of an unusual type and it is impossible to understand the contentions of the parties or to answer the questions posed by Mr. Scarmian, Q.C., without a full appreciation of the details of their design and structure. I had the advantage of seeing two complete models* as well as a number of smaller models to illustrate special details,

* The Corporation are holding these models and certain other physical exhibits.

but the following account (which I have altered only in a few uncontroversial points) was given by Mr. Press, the Senior Quantity Surveyor and Construction Manager to the Corporation, who was nominated as 'Surveyor' for the purposes of the contract in question, and was agreed by all parties as correct in all essentials :

"Along the side of each party wall and the end walls of the terrace there is a piece of timber known as a *trimmer* which is 7" x 2" in cross-section, the 2" being its horizontal dimension. Against the inside face of each of these trimmers is a timber fillet 1" x 2" in cross-section, the 1" being the horizontal dimension. Between the pairs of trimmers across the house there run timber *purlins*, 2" x 7" in cross-section, the 2" being the horizontal dimension, which purlins are not continuous in their length from one trimmer to the other trimmer but are in two pieces which lap approximately in the middle of their combined span. The purlins are spiked (i.e. nailed) to the trimmer. The purlin nearest to the front of the house is approximately 1' 6" from the front wall : and similarly at the rear the nearest purlin is about 1' 6" from the rear wall. From the front purlin there project across the front wall timber *sprockets* (2" x 7") which are nailed from behind the front purlin by two nails. These sprockets are two feet centres along the front of the wall and they rest on the front wall. In the top of the front wall there is cast into a dense concrete beam a dove-tailed timber wall-plate, 2" x 2". A similar description applies to the rear of the house. From the front purlin to the rear purlin in the middle of each span of a part purlin there runs a series of herring-bone strutting—small timber members. In the front part of each house there is a central half-brickwall which runs from the front wall for approximately two-thirds of the length of the house and six pairs of purlins rest on that half-brickwall. Each pair overlap about 1 foot and are nailed together by two nails but are not attached to the wall. The rear three pairs of purlins rest on two steel angles (or joists) which are back to back. They are notched over the steel angle to give a uniform upper surface. The two steel angles were not attached to the rear wall or to the half-brickwall : they merely rested. The construction of the roof covering is by means of counter-battens which run at right angles to the purlins at approximately 2 foot centres. Then is laid thereon a layer of insulating quilt of rock wool. On the insulating quilt are laid battens which run over the purlins but not over the sprockets. This batten is the fixing device for Fural sheeting which is made of aluminium and is fixed to these battens. Where a party wall occurs there is timber boarding placed across the party wall and, according to whether the house curves convex or concave, the boarding is narrower at the front or wider to suit the curve because the roof construction is completely rectangular as the Fural aluminium can only run along a straight roof and cannot itself turn a corner. At the party walls where the curve in the roof is made, the boarding is covered with aluminium which is dressed on either side to the main roofing aluminium. The construction of the roof at the end walls of the terrace is similar to the extent that there is a trimmer with a fillet on its face similar to the construction of a party wall but to accommodate the projecting verge there are sprockets which are at 2 foot centres, 2" x 4" in section, 2" being the horizontal dimension. Nails are driven from behind the trimmer into

these sprockets and the sprockets then rest in holes left or cut in the wall, which is of concrete with a half-brick wall on the outer side. The perimeter of the roof of a terrace is covered by a fascia which is 7" deep all the way round. There is then an asbestos soffit nailed to the underside of the projecting sprockets in every case."

5. In amplification of the foregoing general description the following further facts are of importance :

- (1) The fascia had to be level throughout the length of the terrace. Otherwise the external appearance of the terrace would be ruined.
- (2) The level of the fascia depended on the level of the sprockets to which it was attached.
- (3) Each house had 11 sprockets over the front wall and 11 sprockets over the rear wall.
- (4) Each sprocket was designed to rest fairly and squarely on the wall-plate which was intended to be sunk, dove-tailed, in dense concrete at the top of the front and rear walls.
- (5) The end walls of a terrace had no wall-plate.
- (6) In order to get the trimmers in the right position to receive the purlins and to secure the intended 6 degree pitch of the roof, five mild steel corbels were to be inserted in the "No Fines" walls, projecting 2" from the wall and having 2 holes in the projecting part. These corbels were about 9" long, the end to be put in the wall having a fish-tail shape to give better anchorage.
- (7) The trimmers were to rest on the projecting part of the corbels.
- (8) To build "No Fines" walls it is necessary to erect shuttering of the exact height and width required, between which the concrete would be poured. In this shuttering were cut holes through which the corbels could be inserted into the wall as it was being poured.
- (9) One method of securing the precise positioning of a corbel while concrete was being poured was to fix a wooden block above the corbel in the hole in the shuttering and hold the corbel to it by nails through the holes in the corbel. When the concrete had set both the block and the shuttering would be removed.
- (10) The trimmer would then be "offered up" and positioned on the corbels.
- (11) In the ultimate analysis the positioning of the trimmers determined the level of every other part of the roof structure, for the purlins rested on them and the sprockets were nailed through the purlins and both sprockets and purlins had to be at the same pitch if there were to be proper levels both for the Fural covering and for the fascia.

6. The weight of each roof, including timber structure, quilting and aluminium covering was approximately 3,600 lb. A modern tiled roof of concrete interlocking tiles at a 30 degree pitch covering the same area (about 500 sq. ft.) weighs approximately 7,400 lb. Both weights include a plaster-board ceiling which itself weighs 1,450 lb. and is fixed to the underside of the main roof timbers.

7. A traditional pitched roof is not "anchored" to the walls upon which it rests but in order to "position" it, a wall-plate is put on (but not firmly embedded in) the top of each wall and the roof timbers are invariably nailed to the wall-plate. The roof therefore remains on the walls by its own weight but any timber which crosses a wall-plate is nailed to it.

8. Mr. Kenneth Boyd was the partner in Messrs. Lionel Brett and Kenneth Boyd responsible for the design of these houses and for supervising the execution of the works by the Contractor. Mr. Brett was only concerned in the very initial stages of negotiation and after handing over to Mr. Boyd did not indulge in what he called "back-seat driving" and Mr. Boyd did not ask him to do any "front-seat driving".

Mr. Boyd's responsibility, and his experience and skill as an architect were all matters which were considerably debated. He is now 34 years of age. He became an articled pupil in 1940, joined the Army as soon as he could and remained in it until 1945. He then returned to study at the Architectural Association and became an Associate of the Royal Institute of British Architects in July 1948. As is customary, his theoretical training at the Architectural Association was combined with practical training in the offices of practising architects. In 1949 he joined Mr. Brett as a salaried assistant and at once became immersed in the development of the New Town. Later he became a partner in the firm of Lionel Brett and Kenneth Boyd. In judging his actions therefore it is right to bear in mind that he was, relatively, a young and inexperienced architect and that the Contractors were a firm of great repute and specialists in the "No Fines" technique. These facts did in my opinion have a bearing on what happened: but it should be recorded that I consider that Mr. Boyd was a truthful, one might fairly say a courageously truthful, witness. Where there were discrepancies between his evidence and those of other witnesses, they were of minor importance and arose in my opinion from the inevitable inaccuracy of the human memory. Neither he nor they were trying to mislead.

9. I turn now to a consideration of Mr. Scarman's questions (2)-(6), which involve the consideration of a mass of scientific, technical and factual evidence raising a considerable number of differences of expert opinion, differences of recollection, and so on. By persistent examination and cross-examination many of these differences were resolved or so whittled down as to be of far less importance than at first appeared. For example in the early stages of the Inquiry a good deal of evidence was directed to establishing that the sprockets had not been nailed to the wall-plates in any regular manner and that the corbels were not positioned correctly according to the drawings: but as the Inquiry proceeded it became clear that far from disputing these facts the Contractors accepted and indeed relied on them. To attempt a summary of the evidence would certainly fail to do justice to some, indeed most, of the witnesses unless the Report were impossibly long and complicated. I propose therefore to record my own findings and conclusions with only such references to the details of the evidence as are necessary to make them intelligible.

10. The second of Mr. Scarman's questions was: *Did the design of the houses make any, and if so what, provision for securing the roofs?*

This question must be considered in two parts :

- (1) what was contained in the drawings and specification as to the matter ?
- (2) what, if anything, did the Architect intend to provide thereby with that end in view ?
- (1) (a) The following are the essential provisions in the Specification (all the underlinings being mine) :

[p. 41]

"CARPENTER, JOINER AND IRONMONGER

A. Timber generally . . .

Non-structural timber in wall-plates to be free from loose knots . . .

. . . All carpenters and joiners work shall be put together framed and fixed in the best and most workmanlike manner.

B. Floor boarding . . .

The wood floors are to be laid with boarding . . . and securely fixed to each joint with $2\frac{1}{2}$ " brads punched down.

[p. 42]

E. Roof

Fix at first floor ceiling level $7" \times 2"$ purlins at $2' 0"$ centres with $7" \times 2"$ and $7" \times 3"$ trimmers as indicated on the drawings properly framed and tusk tenoned. The ends of the joists to be supported on $7" \times 2"$ vertical wall-plates* fixed in metal corbels, cast in concrete party walls. Fix $2" \times 1"$ trimmer lath to face of wall-plate and notch ends of joists over lath and box $\frac{1}{2}"$ deep into wall-plate for one half the depth of the plate.

Provide and fix $2" \times \frac{3}{4}"$ fixing battens and $1\frac{1}{2}" \times \frac{1}{2}"$ counter battens with and including nails to receive aluminium roof sheeting at $2' 0"$ centres.

F. Eaves and Verges

Fix at roof level $7" \times 2"$ and $4" \times 2"$ sprockets with and including softwood fascia and bargeboards. All timbers where built in to be twice creosoted before fixing. Provide and fix softwood battens with and including $\frac{3}{16}"$ asbestos cement sheeting as soffits fixed as before described.

[p. 43]

A. First Floor

Fix at first floor level $7" \times 2"$ joists at $18"$ centres with $7" \times 2"$ and $7" \times 3"$ trimmers as indicated on the drawings. Trim opening for staircase and around chimney stack, all as shown, properly

*Note. These "wall-plates" are the trimmers referred to throughout the Report.

framed together with tusk tenoned joints. Two joists shall be bolted together with $\frac{3}{4}$ " diameter bolts and set below partition walls where these occur. The ends of the joists at party walls to be supported on 7" x 2" vertical wall-plate, fixed on metal corbels cast into concrete wall. Fix 1" x 2" timber lath to face of wall-plate and notch ends of joists over lath and box $\frac{1}{2}$ " deep into wall-plate for one half the depth of the plate."

It should be added that on page 37 under "Bricklayers—A. Sundries" the Specification provided for "Bed plates in cement lime mortar". "Bed plates" here were the same as the "wall-plates", referred to elsewhere in this Report.

(b) The following drawings were provided :

(i) Contract Drawing 17 [Exh. DC 5]. Upon this drawing (which was of course one of the Architect's drawings) appear the words "Purlins notched into 7" x 2" wall-plate [=trimmer] carried on mild steel corbels."

(ii) Contractors' Drawing 751/8 [W 2], which was approved by the Architect in August 1955. The Notes to this stated (inter alia): "'C' denotes metal corbel built in 'No Fines' wall to support 7" x 2" wall trimmer." The drawing itself showed 11 7" x 2" sprockets resting on a 2" x 2" wall-plate for both front and back walls and 5 'C's on each party wall.

(c) Neither the Specification nor the Drawings made express provision for nailing of the sprockets to the wall-plate or of the trimmer to the corbels through the holes in the latter.

(2) First did the Architect intend to make any provision for securing the roof? I find that he did so intend. I do not think that the existence of the problem had struck him until his assistant Mr. Watson brought for his approval what were intended to be the final drawings to be agreed with the Contractors. Those drawings showed only 3" x 1" wall-plates resting on and not embedded in the walls. Mr. Boyd then realised that the wall-plates must be thicker and must be secured to the wall, possibly by rag-bolts, and instructed Mr. Watson that since the roof must withstand suction from the wind, these points must be dealt with, but that as a connection with "No Fines" was involved, the Contractors should be consulted.

The drawing 119/C/26 [B 8] was sent by Mr. Watson to the Contractors and returned by them showing the 3" x 1" straight wall-plates amended to 2" x 2" dove-tailed wall-plates. Mr. Boyd took no further action in relation to the Specification which had already been prepared or in preparing the final contract drawings.

Secondly what provision then did he intend to make? I accept his evidence that his intention was that the roof should be secured to the front and back walls primarily by double skew-nailing ("tosh" nailing) through each sprocket to its wall-plate and secondarily by two 4" nails driven vertically into the trimmers through the holes in each corbel.

11. The third question was : *Was such provision sufficient on the basis of such factors as the Architect might reasonably be expected to have taken into account ?*

Mr. Boyd did not consult any engineer or any other architect in connection with this problem. He was not aware of the relevant Code of Practice. He arrived at his appreciation first by consulting a text-book—Hyde Blake's *Building and Structural Tables*—from which he concluded that for a roof of this very low pitch one should anticipate a suction or negative wind pressure of 10 lb. per square foot. He estimated the weight of the roof at 3,000 lb. or 6 lb. per square foot or 2,000 lb. for the whole roof area. Professor Pippard and Mr. James agreed that the estimate was in truth considerably too high. No criticism can be made therefore of this part of Mr. Boyd's calculation. He then considered whether the design as he intended it to be carried out would provide the required anchorage. He assumed that the roof was "a rigid thing in itself" and accordingly to his mind the question was simply whether the intended nailing on the perimeter of the roof was adequate for the purpose. In the course of his work he had once seen a clerk of works test a joint somewhat similar to that proposed for the sprockets and wall-plate by hanging on it : he had himself tested joints in the same way. It was a rough and ready but practical test. Applying it, he concluded that the nailing of the sprockets alone would give well over 2,000 lb. holding strength against suction. He further considered that the nailing of the trimmers through the eorrels with 4" nails would "almost double the value of the sprockets". By this means he satisfied himself that the roofs would be secure.

If his assumption of the rigidity of the roof was correct, it seems reasonably certain that provided the nailing had been done as he intended, the roofs would have held on the night of 3rd/4th November, although the engineering evidence was unanimous in condemning the use of nails in tension as a method of anchorage, and although criticism could be made of the methods of nailing envisaged as not being in accordance with the recommendations of another Code of Practice C.P.112 (1952) pages 30-31, and of the risks of ultimate corrosion of the nails. But while these and other criticisms of the design could be and were justifiably made, the basic criticism levelled at it by Mr. James and Mr. Turner, both consulting engineers called by the Contractors, was that the assumption that the roof was rigid was wrong : that while adequate to deal with a downward load, it was structurally incapable of transmitting a wind load to the points of nailing, which were therefore virtually useless and therefore that the design provided very little anchorage, if indeed any at all, and certainly insufficient to cope with a wind of anything approaching that in fact experienced. Mr. James and Mr. Turner approached the problem from somewhat different angles but to both, the crucial fact was that where the purlins overlapped on the top of the central or spine wall of the house, they were merely nailed together and not secured in any way to the wall, with the result that they could not transmit the load of an upwards suction but would "hinge" or cause the purlins and therefore the roof to "balloon", thereby putting an impossible strain on any nail fastenings on the perimeter. In their view the degree of nailing was "irrelevant" and a negligible factor as a means of anchorage. Nor did they—especially Mr. Turner—regard the subsidiary roof timbers, such as the battening and counter-battening or the herring-boning, as in any substantial degree capable of overcoming this fatal weakness.

The debate on this matter was considerably complicated by the fact that Professor Pippard (who with Mr. Kenyon and Mr. Ferrington had made a preliminary investigation into the causes of the damage at the invitation of the Corporation) had himself assumed that the roof was a rigid structure and in particular that the purlins were effectively jointed where they met at the spine wall. He had therefore to reconsider his conclusions in the light of these criticisms and was recalled towards the end of the Inquiry. He agreed that the criticised joint did constitute a "line of weakness" and that it was bad to use nails for holding down. "I think it is quite the last way I should have chosen myself for doing it. . . . I do not mean by that that there is no strength but it is a bad method". Founding himself however primarily upon what he had himself observed when inspecting the wreckage and particularly the fact that some of the roofs had apparently come off and overturned in one piece, and also upon the accounts given by eye-witnesses and upon the results of certain tests carried out during the period of the Inquiry by the Building Research Station he concluded that the roof structure was capable of transmitting load and did in fact do so and that therefore the nailing or absence of nailing at the sprockets and corbels was of vital importance.

In the result his views were first that the roofs would have stayed on that night despite the defects in design if all the intended nailing had been carried out but secondly that it was doubtful if they would have done so if the nailing had been confined to one skew nail through each sprocket.

I accept these conclusions as the right ones to draw on the evidence. I have no doubt that the theories propounded by Mr. James and Mr. Turner have much substance and would have to be provided for in any alternative design for such roofs but I think that they must have under-estimated the degree of rigidity achieved by the totality of the roof structure. If they were completely right, I find it difficult to understand why the damage was not far worse and more widespread (even allowing for a very large measure of eccentricity in the wind) or why there was so little sign in the houses in which the roofs had lifted but remained on, that the focal point of weakness had been over the spine wall.

My answer to this question therefore is that while the design was theoretically bad in several respects, the roofs would have remained on that night if the Architect's intentions had been fully carried out.

It would be right perhaps to add that the disaster to these roofs provoked a great deal of research into the problem of negative wind pressures and that without it, the errors of design might not have appeared so glaring and might well have been perpetrated by many competent architects.

12. The fourth question is: *Were sufficient steps taken by the Architect to communicate to the builders his intentions for securing the roofs?*

It is I think quite clear that Mr. Boyd did not expressly communicate his intentions to the Contractors and also clear that they never in fact realised that there was any problem of anchorage of the roofs at all. As I have stated above, Mr. Boyd had instructed Mr. Watson to discuss with the Contractors the points he had raised with regard to the wall-plates. Mr. Watson said that he did have a conversation with someone in the Contractors' architectural department and told him that in Mr. Boyd's view the wall-plate was inadequate and

required reconsideration from the holding down point of view. He was however unable to identify the person to whom he spoke: nor were the Contractors able to trace him. I am satisfied that whatever the truth as to this conversation Mr. Watson failed to convey to the Contractors the real importance of the point: that they amended the design with regard to the wall-plate because a dove-tailed plate was from their own point of view more efficient, whatever sort of roof was to be used, and not because they understood that it was to perform a vital anchoring function: and that at the subsequent meeting to discuss the amendments the misunderstanding was not removed. It may well be however that the fact that the amendment was made led Mr. Boyd to believe that the Contractors did understand his intentions. Later Mr. Boyd did have a talk with the Contractors' general foreman, a Mr. Anderson, who has since died, in which the nature of the roof was discussed and Mr. Boyd was at pains to assure Mr. Anderson that though in some respects novel, the essential roof structure was traditional. I think it is possible that this emphasis on the traditional character of the structure may in fact have been misleading since traditional roofs do not require "anchoring". But however that may be, it must be accepted I think that if Mr. Boyd's intentions were communicated to the Contractors at all, it was through the Specification and the drawings. They contained no express reference to nailing at the sprockets or at the corbels nor any indication that anchorage for the roof was necessary. Why then did Mr. Boyd expect nailing to be done in accordance with his intentions; and was he justified in such expectation?

As to the corbels. Mr. Boyd's expectation with regard to the nailing of the trimmers through the corbels was based partly on impressions derived from Mr. Watson's accounts of his discussions with the Contractors which led him to believe that the trimmers were to be "fixed" by nailing through the corbels but mainly I think on the conviction (shared by other distinguished architects) that an ordinary competent builder confronted with two holes of a size to take a 4" nail in a corbel supporting a trimmer and being told in the Specification that the trimmer was to be "fixed in metal corbels" would as a matter of course see that 4" nails were driven through each hole into the trimmer.

I agree with Mr. Kenyon's ultimate conclusion that there were other facts which make it impossible to say that the Contractors can be blamed for not appreciating that this nailing was to be done. I mention the two most important ones:

- (1) The language used in the Specification was the same in relation to the trimmers to be used for the first floor as for those to be used for the roof and the corbels were identical. The only possible purpose of the holes in the first floor corbels was for positioning the trimmer. In the absence of express instructions an ordinary competent builder might reasonably assume that their purpose was the same at roof level;
- (2) The Contractors' drawing 751/8 [W 2] which was approved by the Architect contained the Note "'C' denotes metal corbel built in 'No Fines' wall to support 7" x 2" wall trimmer." These two facts alone would in my opinion be sufficient to excuse the Contractor from being under any obligation to do more nailing than was sufficient to position the trimmer.

In this respect therefore I find that the Architect failed to communicate his intention to the Contractor.

As to the sprockets. The drawings [Exh. DC 5 and W 2] showed the sprockets on the front and back walls crossing the wall-plate. The Specification required all carpenter's work to be "fixed in the best and most workmanlike manner". All the architects called agreed that an ordinary competent builder, and indeed an ordinary competent tradesman, could reasonably be expected as a matter of course to put at least one nail through each sprocket so as to hold it firmly to the wall-plate. There was a division of opinion as to whether ordinary practice demanded single or double skew-nailing. In the circumstances I think the Contractors should have understood that it was the Architect's intention that the sprockets on the front and back walls should be fixed to the wall-plates by at least one nail. Neither the fact that the sprockets on the end walls of a terrace could not be so fixed nor the fact that in other parts of the Specification the word "fix" could only mean "placed on" nor that for some connections the form of nailing was specified nor the fact that the purpose of the nailing had not been made clear to them would suffice in my opinion to excuse a failure to nail each and every one of these sprockets. In this respect I find that the Architect did take sufficient steps to communicate his intentions to the Contractors.

13. The fifth question is : *Did the Contractors build the roofs in accordance with the Architect's design or instructions (including the contract documents and specification) and in a workmanlike manner ?*

Mr. Stewart Brown, Q.C. for the Contractors preferred to put this question thus : "Did the Contractors build the roofs in accordance with the contract documents and to the reasonable satisfaction of the Architect?" I do not think the precise form of the question is of any great significance in determining the causes of the damage. What is important is what in fact happened, and as to that I find the following facts :

- (1) Though there was some variation in the practice, in the initial stages of the contract at any rate the corbels were correctly positioned in the "No Fines" walls through the shuttering. Where any were displaced on the removal of the shuttering or otherwise, they were put right.
- (2) At no time were nails driven through the holes in the corbels as a regular practice but only as and when required to position the trimmer—which was not very often.
- (3) When the walls were complete, the trimmers and purlins were put in.
- (4) The purlins had to be levelled throughout the terrace and if in order to achieve that result, a trimmer had to be raised, it was raised, either by supports from the first floor or by packing up on the corbel.
- (5) The sprockets, fascia boards and soffit had then to be fixed. At this stage it was found that for reasons referred to later, it was impossible to get the fascia board level along the terrace and at the same time keep the sprockets resting on the wall-plate.
- (6) In order to get the fascia board level, the trimmers were raised wherever necessary. This in turn raised the purlins and consequently the sprockets.

- (7) Thus was created a gap between sprockets and wall-plates of varying size but in places as large as 3". This gap was filled by packing, sometimes mortar, sometimes wood or plaster-board, sometimes even bricks.
- (8) The result was that regular nailing of the sprockets to the wall-plates became impossible. Here and there nails could be and were driven, but entirely haphazardly. To all intents and purposes the wall-plates ceased to serve any useful purpose.
- (9) After the trimmers had been got into their final position a skilled man dealt with the corbels, by cutting out some of the concrete above them and then knocking them up into contact with the trimmer or if that were not possible by taking them out and replacing them under the trimmer.

The result undoubtedly was that the roof structure was not built in accordance with the drawings and Specification. It was in truth a totally different structure in respect of the points of fixation. The alteration in the level of the corbels may have seemed of no importance to the men on the job but nonetheless it did involve an alteration in the design of the roof and was therefore a fact of which the Contractors should have notified the Architect before doing it. But far worse in my opinion was their failure to tell the Architect that it was proposed to abandon the use of the wall-plate as a means of holding the sprockets. This was a clear cut departure from the design. In my opinion it is impossible to come to any conclusion but that the Contractors gravely failed in their duty to the Architect in not telling him that they were proposing in substance to abandon his design, because they had found it impossible to carry out. And this failure cannot in my view be excused either on the ground that the Architect or the Clerk of Works must have seen or should have seen what was being done or that the Contractors had no idea that the departure from design was as important as in fact it was.

On behalf of the Architect it was contended that the impossibility was due to the bad workmanship on the part of the Contractors and/or of the sub-contractor, one Haydon, responsible for the carpentry. On behalf of the Contractors it was contended that the design was really an impossible one to achieve. It was said that the effect of the curves in the terraces must result in an irregularity in the level of the sprockets which could account for a gap up to $\frac{3}{4}$ " between certain sprockets and their wall-plate. Mr. Boyd said that he had realised this but considered, and I think rightly, that this by itself would not prevent a satisfactory joining of the two. It was further said that having regard to normal "tolerances" in this class of building it was inevitable that there should be further irregularities in level at the top of the walls due to inaccuracy in the pouring of the concrete along the whole length of a terrace of houses or to permissible variations in the size of the timbers used: that these legitimate tolerances would account for the gap which was found to exist: and that in the absence of any instruction as to anchoring, what was done was a reasonable solution to a practical "in the field" problem.

In my opinion the main cause of the "gap" was the failure to get a proper level at the top of the walls. In the vast number of "No Fines" houses with traditional roofs which the Contractors had erected it was possible to adjust the level of the wall-plates to remedy any "tolerable" inaccuracy in the

pouring of the concrete. In the case of these houses no means of adjustment was provided. If, as Mr. James suggested, the design demanded the impossible, the Contractors as the experts in "No Fines" work should have said so. I was not persuaded that it would have been impossible to have avoided creating a gap so large as to frustrate the design. I think there was bad workmanship in this respect. And if I am wrong and it was impossible, it was the duty of the Contractors to inform the Architect.

It should be added that the problem of this gap was apparently discovered by the Contractors as soon as the first terrace was ready for the fitting of its fascia, and the practice of packing was begun then and continued throughout the contract.

14. The sixth question was : *Did any failure in design or communication or in supervision or in construction contribute in any degree to the causation of the damage ?*

- (1) As to failure of design. I have already said that in my opinion though the design was not a good one, the disaster would not have occurred when it did, if it had been fully implemented in the execution of the works.
- (2) As to failure in communication of design. I have no doubt that Mr. Boyd was at fault in failing to make clear to the Contractors that the light roofs required "anchoring". Nor did he make it clear to the Clerk of Works. And I am by no means sure that even his own assistants fully understood the vital need for proper nailing at the sprockets and corbels. To him the matter was quite plain. Nothing more was required than elementary good carpentry. Therefore there was no need for special explanation. While this is intelligible, I cannot say that this failure was not a material factor in the chain of causation.
- (3) As to failure in supervision. Mr. Fox-Andrews, Q.C., defined the general duty of an architect as being to give such periodical supervision and inspection as may be necessary to ensure that the works are being executed in general in accordance with the contract. He pointed out however that when dealing with State-aided housing schemes architects were required to undertake "general supervision of the work but not constant superintendence". Mr. Boyd and his assistants probably made more visits to the site than they were bound to do. There was no lack of keenness. But the plain fact remains that neither he nor his assistants nor the Clerk of Works realised that things were going seriously wrong. This is the most incomprehensible part of the whole case. Mr. Boyd himself visited the works often and must have had opportunities of seeing that the work was not being done as he intended. In fact he went when some of the first roof structures, including the sprockets, were being put in. When asked whether he was surprised that he had not noticed the state of affairs discovered after the disaster he replied "I put that question to myself every day since November. I visited the roof many times and at no time did I see anything to equate with what I discovered in the debris . . . at no time, while I did not go up on anything like all the roofs—far from it—did I see anything approaching the malpractice, that is all I can call it, at the top of the

walls. How it came not to be revealed to me when I was up there, if I was on a block, defies my explanation." And later he said that at no time did he see packing and sprockets being put together and that he was completely ignorant that there was any packing until after the event. I accept his evidence, astonishing though it may be. I think he failed to see what was happening because his mind was on other problems. This question of anchorage was never to him a burning vital problem and therefore he did not see what must have been at some comparatively early stage under his very nose. I see no escape from the conclusion that Mr. Boyd ought to have seen what was happening and to have realised its significance. His failure to do so must in my opinion be regarded as one of the major factors in the chain of causation. His assistants who also visited the site frequently may perhaps not be blamed for not realising its full significance but again it is difficult to understand how they never even mentioned to Mr. Boyd that the whole roof structure was being raised. The position of Mr. Garnett the Clerk of Works is equally mysterious. Not a quick-witted man it is true but no-one suggested that he was unconscientious and yet apparently he never realised that neither the sprockets nor the corbels were being nailed as he understood they should be (though not the real reason why) or that the sprockets were being regularly packed with permanent packing. Nor did he report to the Architect that corbels were being regularly repositioned, a fact which he did observe. Mr. Wells, the Contractors' assistant, and later general, foreman, said that Mr. Garnett had instructed him to pack up under the sprockets with mortar. Mr. Garnett agreed that he had given such an instruction to close a gap between soffit and wall which Mr. Boyd and he had observed extending over a short distance but strongly maintained that he had never sanctioned permanent packing under the sprockets. On this issue I think Mr. Garnett's account is the more reliable in that it is to some extent corroborated by Mr. Boyd and by at least one photograph. But it is I think impossible to acquit Mr. Garnett altogether. He ought to have seen what was being done and if he did see it, he ought to have reported it, even if he did not realise its full significance, for it was a clear departure from the Architect's instructions as shown in the drawings.

Lastly there is the position of the Contractors. For the first half of the contract the general foreman was Mr. Anderson: he died and with him, his evidence. Mr. Wells had been his assistant and became his successor, and was called to give evidence. His attention was directed to photograph 13 in Exhibit B which showed the top of a wall with something like 3" of packing. He admitted that that showed a state of affairs that ought not to have existed, that he knew that it was being brought into existence, that it was not in accordance with the Architect's drawings but that he did not call this departure to the attention of Mr. Boyd or his assistants. (In parenthesis I should say that the two nails to be seen in photograph 13 were certainly not nails through sprockets. I saw several other examples and whatever their purpose, it was not to nail sprockets to wall-plates.) Mr. Wells was clearly not very happy about his position but it is only fair to him to

APPENDIX B

List of Exhibits

DC 1	Wind Chart
DC 2	Wind Table I
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DC 4	Building Contract
DC 5	Contract Drawings
DC 6	Specification
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B 6	Architect's Wind Calculations
B 7	Correspondence
B 8	119/C/26 Annotated by Wimpeys
B 9	Comment on photographs
B 10	Dg. 200/731 : Wimpey Dg.
B 11	Schedule relating to photographs
B 12	Addendum to Kenyon's Report
B 13	Memorandum taken to August 1952 Meeting
Kenyon 1	Isometric View showing roof carcassing



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Printed in Great Britain by Fosh & Cross Ltd., London
and published by

HER MAJESTY'S STATIONERY OFFICE